

**ANSI/AHRI Standard 460
(formerly ARI Standard 460)**

2005 STANDARD for
**PERFORMANCE RATING OF
REMOTE MECHANICAL- DRAFT
AIR-COOLED REFRIGERANT
CONDENSERS**



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IMPORTANT

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Note:

This standard supersedes ARI Standard 460-2000.

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PERFORMANCE RATING OF REMOTE MECHANICAL-DRAFT AIR-COOLED REFRIGERANT CONDENSERS

Section 1. Purpose

1.1 Purpose. The purpose of this standard is to establish for Remote Mechanical-Draft Air-Cooled Condensers: definitions; test requirements; rating requirements; minimum data requirements for Published Ratings; marking and nameplate data; and conformance conditions.

1.1.1 Intent. This standard is intended for the guidance of the industry, including: manufacturers, designers, installers, contractors and users.

1.1.2 Review and Amendment. This standard is subject to review and amendment as technology advances.

Section 2. Scope

2.1 Scope. This standard applies to Remote Mechanical-Draft Air-Cooled Refrigerant Condensers as defined in Section 3 for use with or without external air resistance.

2.2 Exclusions.

2.2.1 This standard does not apply to Air-Cooled Condensers designed primarily for installation within the machinery compartment of a self-contained product or in a factory-assembled condensing unit.

2.2.2 This standard does not apply to remote mechanical-draft evaporatively-cooled refrigerant condensers as covered by ARI Standard 490.

Section 3. Definitions

3.1 Definitions. All terms in this document follow the standard industry definitions in the current edition of *ASHRAE Terminology of Heating, Ventilation, Air Conditioning and Refrigeration* unless otherwise defined in this section.

3.2 Bubble Point. Refrigerant liquid saturation temperature at a specified pressure.

3.3 Dew Point. Refrigerant vapor saturation temperature at a specified pressure.

3.4 Entering Air Dry-Bulb Temperature. The average dry-bulb temperature of the ambient air entering the condenser assembly, °F [°C].

3.5 Entering Air Wet-Bulb Temperature. The average wet-bulb temperature of the air entering the condenser assembly, °F [°C].

3.6 Net Refrigeration Effect. The rate of total heat absorption by the refrigerant, at stated evaporator conditions, of the complete refrigeration system. This effect is equal to the product of the refrigerant mass flow rate through the system and the enthalpy difference between the refrigerant vapor leaving the evaporator and the refrigerant liquid entering the liquid control device of the evaporator, Btu/h [W].

3.7 Published Rating. A statement of the assigned values of those performance characteristics, under stated Rating Conditions, by which a unit may be chosen to fit its application. These values apply to all units of like nominal size and type (identification) produced by the same manufacturer. The term Published Rating includes the rating of all performance characteristics shown on the unit or published in specifications, advertising or other literature, including computer software and computer-generated reports, controlled by the manufacturer, at stated Rating Conditions.

3.7.1 *Application Rating.* A rating based on tests performed at application rating conditions (other than Standard Rating Conditions).

3.7.2 *Standard Rating.* A rating based on tests performed at Standard Rating Conditions.

3.8 *Rating Conditions.* Any set of operating conditions under which a single level of performance results and which causes only that level of performance to occur.

3.8.1 *Standard Rating Conditions.* Rating Conditions used as the basis of comparison for performance characteristics.

3.9 *Remote Mechanical-Draft Air-Cooled Refrigerant Condenser (Air-Cooled Condenser).* A factory-made encased unit which is intended for connection in the field by means of refrigerant piping, and which includes a means for forced-air circulation and elements by which heat is transferred from refrigerant to air. The purpose of this unit is to condense refrigerant vapor by rejecting heat to the air.

3.10 *Saturated Condensing Temperature (Condensing Temperature).* For single component and azeotrope refrigerants, the saturation temperature corresponding to the refrigerant pressure at the condenser entrance. For zeotropic refrigerants, the arithmetic average of the Dew Point and Bubble Point temperatures corresponding to the refrigerant pressure at the condenser entrance.

3.11 *"Shall" or "Should".* "Shall" or "Should" shall be interpreted as follows:

3.11.1 *Shall.* Where "shall" or "shall not" is used for a provision specified, that provision is mandatory if compliance with the standard is claimed.

3.11.2 *Should.* "Should" is used to indicate provisions which are not mandatory but which are desirable as good practice.

3.12 *Standard Air.* Air weighing 0.075 lb/ft³ [1.2 kg/m³], which approximates dry air at 70°F [21°C] and at a barometric pressure of 29.92 in Hg [101.3 kPa].

3.13 *Subcooling.* The difference between the saturation temperature corresponding to the liquid pressure at the coil outlet and the liquid refrigerant temperature at the coil outlet, °F [°C].

3.14 *Temperature Difference (TD).* The difference between the Saturated Condensing Temperature and the Entering Air Dry-Bulb Temperature, °F [°C].

3.15 *Total Heat Rejection Effect (Capacity).* The rate of total heat removal from the refrigerant. This effect is equal to the product of the mass flow rate and enthalpy difference between the refrigerant vapor entering the condenser and the refrigerant liquid leaving the condenser, Btu/h [W]. (The Total Heat Rejection Effect, for all practical purposes, is equal to the Net Refrigeration Effect in the evaporator of the system plus the heat added to the refrigerant by the refrigerant compressor.) As an alternative, this effect may be expressed in terms of its Net Refrigeration Effect for a specific system.

Section 4. Test Requirements

4.1 *Testing Requirements.* Remote Mechanical-Draft Air-Cooled Refrigerant Condensers shall be tested for rating purposes in accordance with the test methods presented in ANSI/ASHRAE Standard 20, except that the measured heat rejection shall be adjusted to the design temperature difference using the following formula:

$$q_c = \frac{q_m (TD_s)}{TD_m}$$

where:

- q_c = corrected heat rejection rate, Btu/h [W]
 q_m = measured heat rejection rate, Btu/h [W]
 TD_s = standard Temperature Difference at Standard Rating Conditions, °F [°C]
 TD_m = measured Temperature Difference, °F [°C]

4.2 Test Conditions. Actual test conditions shall not deviate from Standard Rating Conditions by more than the following:

| | |
|-----------------------------------|-----------------------|
| Barometric Pressure | ±1.5 in Hg [±5.1 kPa] |
| Entering Air Dry-Bulb Temperature | ±1°F [±0.6 °C] |
| Saturated Condensing Temperature | ±1°F [±0.6 °C] |
| Discharge Superheat | ±10°F [±5.6 °C] |

4.2.1 Even though the average Entering Air Wet-Bulb Temperature and liquid refrigerant Subcooling at the condenser outlet temperatures are not specified in Table 1, these temperatures shall be recorded with each set of test readings.

4.3 Standard Auxiliary Components. If motor hoods, wind deflectors, dampers, fan guards, coil guards or other air-side components are furnished as standard, they shall be in place during the test. If any head-pressure controls, sub-coolers or other refrigerant-side components are furnished as standard, they shall be in place during the test.

Section 5. Rating Requirements

5.1 General. Standard Rating(s) for Remote Mechanical-Draft Air-Cooled Refrigerant Condensers shall be determined when tested at the Standard Rating Conditions specified in 5.1.1.

5.1.1 Standard Rating Conditions. Standard Ratings shall be determined by tests, using the methods of testing set forth in Section 4 and performed at the Standard Rating Conditions specified in Table 1.

5.1.2 Application Rating Conditions. Ratings at conditions other than those specified in 5.1.1 may be published as Application Ratings and shall be based on test data determined in accordance with Section 4.

Table 1. Standard Rating Conditions^{1,2}

| | All Refrigerants | |
|--|-----------------------|-----------|
| | I-P | SI |
| Barometric Pressure | 29.92 in Hg | 101.3 kPa |
| Entering Air Dry-Bulb Temperature | 95 °F | 35 °C |
| Saturated Condensing Temperature | 125 °F | 51.7 °C |
| Actual Temperature of Refrigerant Vapor Entering Condenser | 190 °F | 87.8 °C |
| External Static Pressure | 0 in H ₂ O | 0 kPa |
| ¹ Standard Rating Tests shall be conducted at the nameplate-rated voltage(s) and frequency. For units with dual nameplate voltage ratings, standard rating tests shall be performed at both voltages or at the lower of the two voltages if only a single standard rating is to be published. ² Piping and charging shall be done in accordance with the manufacturer's specifications. | | |

5.2 Published Application Ratings. Application Ratings represent the performance characteristics of a specific condenser at various operating or design conditions. They are used for the purpose of selecting a condenser for any set of design conditions

within the operating range for which the condenser is intended, and they shall be derived from tests made in accordance with the method prescribed in Section 4.

5.2.1 *Application Rating Terms.* Whenever Application Ratings are published or printed, the conditions at which these ratings apply shall be shown. Application Ratings shall include, or be accompanied by, the Standard Ratings clearly identified as such. In addition, Application Ratings shall be published in the terms as shown in 6.2.

Application Ratings shall also include the Total Heat Rejection Effect, which shall be expressed in the same terms as the Standard Rating. The Temperature Difference (TD) or other design basis for which the ratings are given shall be clearly specified.

5.3 *Tolerances.* To comply with this standard, published values of Standard Ratings or reported capacity ratings shall be based on data obtained in accordance with the provisions of this section. The measured Total Heat Rejection Effect of any representative production unit shall not be less than 95% of the published Standard Rating and the measured power input shall not be more than 105% of rated power input.

5.4 *Optional Auxiliary Accessories.* If the components described in 4.3 are available from the condenser manufacturer, but not furnished as standard, their effect on condenser performance shall be clearly stated in the manufacturer's Published Ratings.

Section 6. Minimum Data Requirements for Published Ratings

6.1 *Minimum Data Requirements for Published Ratings.* As a minimum, Published Ratings shall include all Standard Ratings. All claims to ratings within the scope of this standard shall include the statement "Rated in accordance with ARI Standard 460". All claims to ratings outside the scope of this standard shall include the statement "Outside the scope of ARI Standard 460". Wherever Application Ratings are published or printed, they shall include a statement of the conditions at which the ratings apply.

6.2 *Published Standard Ratings.* Standard Ratings shall be published in the following terms:

- a. Total Heat Rejection Effect, Btu/h [W]
- b. Fan motor power input, W [kW]

6.2.1 *Additional Information.* Published Standard Ratings shall also be accompanied by the following information:

- a. Weight of condenser operating charge, lb [kg]
- b. Unit electrical nameplate data
- c. Overall and mounting dimensions, ft [m]
- d. Connection sizes, in [mm]
- e. Operating weight, lb [kg]
- f. Subcooling, °F [°C] (required only when subcooling exceeds 5°F [3°C])
- g. Airflow through the condenser with no external ductwork (0 in H₂O [0 kPa] external static pressure), cfm [m³/s] of Standard Air
- h. Refrigerant designation(s) in accordance with ANSI/ASHRAE Standard 34 with Addenda

Section 7. Marking and Nameplate Data

As a minimum, the model number, serial number, name and location of manufacturer (or trade name), refrigerant(s), maximum working pressure and electrical characteristics shall be shown on a nameplate located in a conspicuous place on each condenser. Nameplate voltages for 60 Hertz systems shall include one or more of the equipment nameplate voltages shown in Table 1 of ARI Standard 110. Nameplate voltages for 50 Hertz systems shall include one or more of the utilization voltages shown in Table 1 of IEC 60038.

Section 8. Conformance Conditions

8.1 *Conformance.* While conformance with this standard is voluntary, conformance shall not be claimed or implied for products or equipment within the standard's *Purpose* (Section 1) and *Scope* (Section 2) unless such product claims meet all of the requirements of the standard and all the requirements of the testing and rating requirements are measured and reported in complete compliance with the standard. Any product that has not met all the requirements of the standard shall not reference, state, or acknowledge the standard in any written, oral, or electronic communication.

APPENDIX A. REFERENCES - NORMATIVE

A1 Listed here are all standards, handbooks and other publications essential to the formation and implementation of the standard. All references in this appendix are considered as part of the standard.

A1.1 ANSI/ASHRAE Standard 20-1997, *Method of Testing for Rating Remote Mechanical-Draft Air-Cooled Refrigerant Condensers*, 1997, American National Standards Institute/American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., 25 West 43rd Street, 4th Floor, New York, NY 10036, U.S.A./1791 Tullie Circle N.E., Atlanta, GA 30329, U.S.A.

A1.2 ANSI/ASHRAE Standard 34-2004 with Addenda, *Designation and Safety Classification of Refrigerants*, 2004, American National Standards Institute/American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., 25 West 43rd Street, 4th Floor, New York, NY 10036, U.S.A./1791 Tullie Circle N.E., Atlanta, GA 30329, U.S.A.

A1.3 AHRI Standard 110-2002 (formerly ARI Standard 110-2002), *Air-Conditioning and Refrigerating Equipment Nameplate Voltages*, 2002, Air-Conditioning, Heating, and Refrigeration Institute, 2111 Wilson Blvd., Suite 500, Arlington, VA 22201, U.S.A.

A1.4 AHRI Standard 490-2003 (formerly ARI Standard 490-2003), *Remote Mechanical-Draft Evaporatively-Cooled Refrigerant Condensers*, 2003, Air-Conditioning, Heating, and Refrigeration Institute, 2111 Wilson Blvd., Suite 500, Arlington, VA 22201, U.S.A.

A1.5 ASHRAE *Terminology of Heating Ventilation, Air Conditioning and Refrigeration*, Second Edition, 1991, American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc. 1791 Tullie Circle, N.E., Atlanta, GA, 30329, U.S.A.

A1.6 IEC Standard 60038, *IEC Standard Voltages*, 2002, International Electrotechnical Commission, 3, rue de Varembe, P.O. Box 131, 1211 Geneva 20, Switzerland.

APPENDIX B. REFERENCES - INFORMATIVE

None.